The amazing sound in Rockport:
Gorgeous Shalin Liu Proves Dry and Exciting Better Than Muddy, Reverberant

By David Griesinger

For the concert by the Parthenia Consort of viols with guest tenor and actor at the new Shain Liu Performance Center in Rockport on June 13, I chose a seat in row M, just three rows from the back of the stalls, because I wanted to hear the clarity of the sound in an average seat, not a seat reserved for critics. The verdict: Larry Kirkegaard deserves high praise for his work in this hall. It is not easy to create a shoebox hall of this size where the music can be heard clearly in a large majority of seats.

The shoebox shape was dictated both by convention and by the footprint of the site. In a short film that played before the start of the concert, the architects (Epstein Joslin Architects, in Cambridge) explained that "we knew we had the right shape – it is a shoebox – all the great concert halls are shoeboxes." This statement is common knowledge with the public and acousticians – but it does not stand up to common sense.

There are far more mediocre shoebox halls than great ones, and more are being built all the time. In Beranek's surveys of musicians and conductors only three are rated "excellent"; our beloved Boston Symphony Hall is one of them. The odds of building an excellent new hall with this shape do not appear to be very good. Other options exist: Jordan Hall at New England Conservatory is a Mecca for chamber musicians and audiences all over the world; Sanders Theater at Harvard has almost as good a reputation. Neither is a shoebox. Both are semi-circles with a large high balcony. They succeed at bringing the average listener closer to the musicians than a shoebox, and with their high ceilings both provide fine reverberation. In the previous venue the Rockport Music Festival audience closely surrounded the musicians. The sound was dry – but the music was very exciting. Dry and exciting is almost always better than muddy and reverberant for chamber music. But the public, architects, and large donors demand the shoebox shape. To see how the new hall in Rockport defies the odds we need to look at human perception of music.

Sound Perception in halls

Size matters because of the way the brain processes sound. In an excellent hall (like Boston Symphony, Jordan, and much of the time in Rockport) you can (with practice) hear all the notes in the music separately, and tell which instruments played them. You can also hear the reverberation of the hall as separate from the foreground notes. To hear all the notes separately your brain must be able to process the sound that comes directly from the instruments. But the direct sound is easily muddled by excess early reflections. The brain needs about 1/10th of a second of un-muddled direct sound to detect the pitch, timbre, direction, and distance of each player or section as separate from the others. If the energy in the direct sound at the start of each note is greater than the total energy in the reflections for this critical tenth of a second, the brain can detect all the information we need. If the energy in the reflections is greater in this 1/10th of a second, the instruments blend together. The reverberation has become the notes – audible as chords, but not as separate sources. We can hear the harmonies, but much of the excitement of the music is lost.

The kind or enveloping reverberation that gives a hall its richness is only audible if the direct sound is separately detected, and then only after the critical 1/10th of a second has elapsed. If the majority of the reverberant energy has decayed before this time the hall will be perceived as dry. In brief – we only hear all the notes if the direct sound is stronger than sum of all the reflections in the first tenth of a second, and we only hear the reverberation as separate if it is still strong enough to be heard after this period has elapsed.

But there is an additional factor about perception that we need to know. The frequencies that carry information about the pitch, timbre, direction, and distance of the notes are the frequencies of vowel formants in speech – roughly 700Hz to 4000Hz. It is not surprising that our ears are most sensitive to these frequencies, and that cell phones usually reproduce no others. But the richness we desire from reverberation lies primarily at the frequencies of instrumental and vocal fundamentals. So a critical element in the success of excellent halls is the frequency dependence of the reverberant energy. If the reflections and reverberation are strong at low frequencies and less strong at the formant frequencies, clarity and reverberance can co-exist.

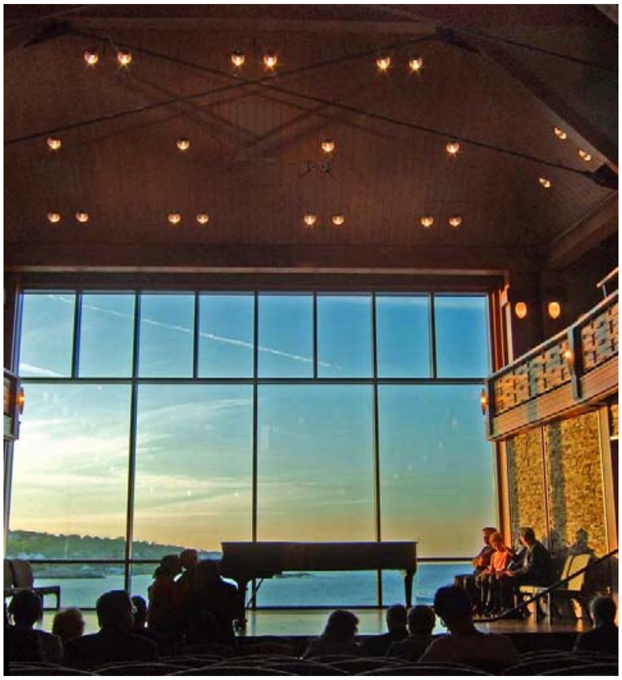
Excellent shoebox halls succeed in part by being large enough that there is sufficient delay before early and late reflections reach our ears. Most of the reflected energy arrives after the critical 1/10th of a second. We have time to process the information in the direct sound. For the same reason reverberation is audible after the critical interval. All large shoebox halls do this for some of the seats. But as we move back into the hall the direct sound becomes weaker, and the reflections from the ceiling and side walls come relatively stronger and sooner. At some point the direct sound blends in with the reflections. At this point we lose the ability to separate the instruments. The sound becomes “well blended” which is probably the most optimistic way to describe an unfortunate situation. Additionally, all the shoebox halls we consider excellent include elements that reduce the strength of the reflections above 700Hz in the rear of the hall – thus increasing the audibility of the direct sound in the rear without sacrificing the loudness and richness of the reverberation. This increases the number of good seats.

With these facts in mind we can see why the size of a hall is so important. If you take the shape of Boston Symphony Hall and scale it to smaller sizes, all the reflections come sooner. But our brains do not scale, and the tempo of the music does not scale either. Reflections that once fell outside 1/10th of a second now fall inside it, and the number of seats in which the direct sound can be distinctly heard goes down. Scaling the hall will also reduce the reverberation time. If nothing is done to change the ratio of hall volume to seating area, we would expect the reverberation time in a 330-seat shoebox to be one-third the reverberation time in Boston Symphony – or about 0.6 seconds. With this reverberation time the strength of the late reflections decreases below the level of audibility, and audiences will complain about the dry sound.

Increasing the reverberation time in a small hall by removing absorption raises the strength of both early reflections and late reflections, further reducing the audibility of the direct sound. The resulting sound is “well blended” in almost all the seats. When I heard in the movie before the concert that the design goal for the reverberation time in Rockport was 1.5 seconds, I had great trepidation about the sound I was about to hear.

The features that reduce the reverberant energy above 700Hz in an excellent large hall – such as coffers and niches - also do not scale with size. They have to be full-size to work. Make them smaller and the frequencies they affect become too high to be of interest. Another feature that makes a great hall worth traveling to hear is the stage house – or lack thereof. The stage house in Boston is high, wide, and shallow, with slanting sides and ceiling that project the sound away from the stage and into the hall. Amsterdam and Vienna have no stage house at all. The deep reverberant stage houses in halls like New York's Avery Fisher muddle the sound of instruments inside them.

But the sound in Rockport is remarkably good. How did Kirkegaard and the architect do it? As usual, the devil – or in this case the art – is in the details. The stage has outward sloping side walls, and the ceiling over it is high and slanted outward. But most importantly – the sound I heard did not have a reverberation time of 1.5 seconds. To my ears the RT was below one second above 500Hz. It was longer – perhaps even 1.4 seconds – below 500Hz. This is a nearly ideal frequency dependence to yield both clarity and resonance at the same time. Kirkeggard managed to reduce the strength of the reflections above 700Hz sufficiently to keep the direct sound audible to at least row M. *How did he do it?* A sharp-eyed friend noticed felt on the roof timbers on the side facing the players. Another friend noticed that the walls along the side balconies in the front of the hall are not reflecting, but covered by removable absorption. Additionally, the concert was sold-out, so the audience was soaking up the maximum in middle and late energy.



Golden hour image from RCMF Day 2 (BMInt Staff)

The screens woven of thin wooden strips that cover the huge window behind the players were drawn back before the concert started, exposing a scene of brightly illuminated fog. I asked the hall manager if they would be closed for at least part of the concert, as I thought the sound would be better, and the back-light behind the players was highly distracting. He said he planned to shut them for part of the concert. Fortunately, the curtains were shut for the whole concert.

Parthenia Ensemble Poses for David Griesinger

Sidewall detail (David Griesinger photo)

The curtains are beautiful, woven of thin strips of wood with gaps between that let through scallops of light. They are also sound absorbing, which I found by tapping them. The strongest – and most disturbing – early reflection in a small hall is usually the one from the back of the stage. With the curtains open that surface would be perfectly reflecting glass. With the curtains closed the back-wall reflection is attenuated above 700Hz. Thank goodness! The motif of woven wood is repeated around the balcony fronts, with a visually beautiful, and sonically important result

The movie about the hall suggested that the stage was deliberately placed low so that the audience would feel more intimately connected to the players. This design has a beneficial sonic effect. The geometry is such that the side-wall reflections that would otherwise be audible in row M do not hit the side wall, but are absorbed by the balcony fronts and the audience sitting behind them. The reflections that would normally come to row M from the under surface of the side balconies are broken up by the large exposed beams that support the balconies. Listeners in the front of the balcony at the rear have the same advantages, as the lateral reflections are blocked by the under surface of the side balconies. For both the balconies and the stalls the ceiling reflections are attenuated by the distance to the high ceiling, and are broken up at high frequencies by the exposed beams and the (largely invisible) felt. The result: with the front curtains closed listeners in the rear of the stalls and the balconies do not receive the strongest early reflections, giving the direct sound more time to be heard.

There is another important reason for the unexpected clarity I heard in this concert – the instruments and the performers. The human voice, and the sound from a viol, is directional. The voice radiates most of the formant frequencies forward to the listeners, and the top surface of a viol does the same. There is roughly a 2dB to 3dB increase in the direct sound relative to reflections due to this directivity alone. The same advantage accrues to the first and second violins in a string quartet – with either the cello or the viola at a distinct disadvantage. The viols were more directive than the mezzo-soprano in the concert I heard – and were distinctly clearer. More omni-directional instruments, such as the flute mentioned in Vance Koven's review of the opening concert, will not have these advantages.

The vibrato-less performance practice is also important. It is easier for the brain to separate instruments by pitch if that pitch is stable. The sound of a viol consort cuts through acoustics that might otherwise be muddy. The mezzo-soprano was distinctly more reverberant than the viols in my seat. The narrator had no such problem. Speech typically has much shorter notes than song, and short notes excite the hall less than long ones. Speech intelligibility in this hall is very good.

The bottom line – for this particular concert, with the window screens in place, in this particular seat (and according to my friends, in a great many of the other seats) the sound was clear and adequately reverberant. The visual impression was stunning, and the musicians were close enough to feel intimately connected to the listeners. In the opening concert the screens were open but there was audience behind the musicians absorbing the stage back wall reflections. How the hall sounds with a smaller audience, more omni-directional instruments, and the window screens withdrawn, remains to be seen. But the Shalin Liu Performance Center is off to a very good start.

View to rear of auditorium (David Griesinger photo)